of the strengths of the acids themselves, but in terms of the concentration of hydrogen-atoms in the liminal solution (gram-molecules normal per liter). It will be seen that the hydrogen-concentration is not constant. The order in which the liminal solutions of the three acids come, in regard to this value, which is necessarily the order of their sapidity as related to hydrogen-concentration, is: Hydrochloric, Sulphuric, Acetic. But this is also the order in which they stand with regard to the percentage of ionization in solution.[8] It is to be noted further that the values for hydrochloric and sulphuric acids differ but slightly, which is in accord with the well-known principle that the inorganic acids tend towards complete (and therefore equal) ionization as the solution becomes very dilute. The concentration of hydrogen in the liminal solution of acetic acid, however, is less than twice that of either of the other two acids. Yet the maximal dissociation of acetic acid in the weakest solutions does not exceed 6%, as against a dissociation approaching 100% for the two inorganic acids.[9]

We must conclude, then, that the sapidity of hydrochloric and sulphuric acids seems to depend upon their concentration in hydrogen-ions (concentration in hydrogen-atoms multiplied by the percentage of ionization), but that acetic acid exhibits a stronger taste than its low ionic concentration would justify. These conclusions are a verification, by a more exact procedure, of the results obtained by earlier investigators.

II. The Daylight Mazda Lamp in the Psychological Laboratory.

By Gilbert J. Rich

It has been shown by Brown[1] that artificial daylight produced by means of Gage's glass may be substituted for natural daylight in color-mixing with only slight effect upon the color-equations obtained. The use of some form of artificial daylight presents many advantages, especially because with it one has a light of constant intensity, a great aid in working out the third law of color-mixture. Many laboratories, however, find the cost of Gage's glass prohibitive. More recently the General Electric Company has placed upon the market a new 'daylight' bulb, the "C-2 Mazda," which sells at prices averaging about 20% above the cost of plain nitrogen bulbs of the same intensity. These prices are within reach of the smallest laboratory, which must in any case spend money for electric bulbs of one sort or another, and can now obtain the 'artificial daylight' with only a slight increase in expenditure. In order to ascertain the value of this new light, we have compared color-matches made under its illumination with matches made in natural daylight.

[8] J. W. Mellor, *Chemical Statics and Dynamics,* 1909, 194f.

[9] Mellor, *loc. cit.* We unfortunately did not have at hand facilities for making a direct determination of the per cent of ionization of the solutions which we found to be liminal.

[1] A. J. Brown, Some Uses of Artificial Daylight in the Psychological Laboratory, *Amer. Jour. Psych.,* 27, 1916, 427ff.

The artificial light was furnished by a 150-watt C-2 mazda bulb placed some 3 meters in front of (and above) the color-mixer in a dark room (black walls). The matches used for comparison were made in a room with light walls and two large windows facing east, and only on bright afternoons. In both cases the observer sat 4 meters from the color-mixer. The following papers were used: Orange (O), Blue-Green Shade No. 1 (BG), Green Shade No. 2 (G), and Violet Shade No. 2 (V) of the Milton-Bradley series; and Blue (B), Orange-Yellow (OY), Yellow-Green (YG), Red (R), Black (Bk), and White (W) of the Hering series. Matches were made for eight observers, all of whom had had some practice in color-mixing.

In our first match, G and Y were equated to YG weakened by the addition of Bk and W. In the second combination, O and BG, which seemed to be complementary under the artificial light, were matched to a mixture of Bk and W. They were not, however, complementary in natural daylight, so that it was necessary to add small amounts of B in order to match the gray. And, thirdly, B and R weakened by Bk and W were matched to V.

The averages and mean variations for the eight observers taken together are shown in the accompanying tables, together with the average difference between the results obtained under the two illuminations. There are also included the greatest difference and the least difference for any single observer between the two kinds of lighting, as well as the ratios between the amounts of B and R in the third equation. All measurements are in degrees.

The first match shows that the artificial light which we are testing does no great violence to the hues in the middle of the spectrum. The differences between illuminations are sometimes more, sometimes less, than the *mv* between observers, but are in general comparable to these. A much greater discrepancy is to be found in the blues, as the second of our matches shows. The electric bulb is deficient in blue rays, and therefore gives a yellowish light. A combination of Bk and W on the color-wheel is, then, a very pale yellow instead of a gray, and the seemingly complementary O and BG were actually matched to this yellow under the artificial light. In the natural light, on the other hand, the mixture of BK and W gave a true gray, so that it was necessary to add small quantities of B to the yellowish combination of O and BG before a match was obtained. The third trial shows this same derangement. Since B is less effective under the electric light than in natural daylight, a greater proportion of it in the combination is necessary to match the V. Moreover, since the V contains a large percentage of blue, the paper appears as less saturated in a light which

MATCH NO. 1

		Outside		Inside		
		G	Y	YG	B	W
Natural	Average	312.1	47.9	140.8	192.9	26.3
	Mv	3.2	3.2	6.1	6.5	6.5
Artificial	Average	306.4	53.6	145.8	188.3	25.9
	Mv	1.8	1.8	5.4	4.0	4.3
Average Difference		5.7	5.7	5.0	4.6	.4
Greatest Difference		18.0	18.0	18.0	16.2	21.6
Least Difference		0	0	0	1.8	0

MATCH NO. 2

		Outside			Inside	
		O	BG	B	Bk	W
Natural	Average	62.7	289.4	7.9	276.1	83.9
	Mv	1.1	4.0	4.0	2.2	2.2
Artificial	Average	59.4	300.6	.....	271.8	88.2
	Mv	1.4	1.4	.....	1.8	1.8
Average Difference		3.3	11.2	7.9	4.3	4.3
Greatest Difference		7.2	18.0	14.4	9.0	9.0
Least Difference		0	3.6	0	1.8	1.8

MATCH NO. 3

		Outside			Inside		Ratio
		B	R	Bk	W	V	B/R
Natural	Average	162.0	93.2	103.7	1.1	Constant at 360.	1.7
	Mv	7.9	7.9	9.4	1.8		.....
Artificial	Average	123.9	61.9	163.4	10.8		2.0
	Mv	6.5	4.7	6.8	1.1		.....
Average Difference		38.1	31.3	59.7	9.7		.....
Greatest Difference		57.6	48.6	72.0	14.4		.....
Least Difference		14.4	12.6	32.4	3.6		.....

is deficient in blue rays. As a result, smaller amounts of color (both R and B) were necessary to obtain a match in the artificial light, as the table shows. We must conclude, then, that the Mazda lamp, although dependable through the middle range of the spectrum, gives a light which is markedly deficient in blue rays as compared with daylight.[2]

A comparison of the *mv* between observers under the two illuminations is worthy of note. The average *mv* is 4.7 in the natural, and 3.3 in the artificial light. This difference, though too small to be of real value, is at least indicative of the greater constancy of result that may be obtained when an artificial source of light is used. We have, indeed, found in this laboratory that third-law-matches invariably check when the Mazda light is used, while the difficulty of checking these color-equations in daylight is known to every laboratory worker.

The C-2 Mazda light differs from daylight in too great a degree to permit its use in research work. On the other hand, it is close enough to the natural light to be used to demonstrate the laws of color-mixture in the ordinary laboratory course, for which purpose it has the advantage of constant intensity.

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[2] Dr. E. G. Boring has kindly called our attention to a simple demonstration of this deficiency by the principle of the Hering window. If a rod is so arranged as to cast a double shadow upon a white surface illuminated by a slit in a window and a C-2 Mazda lamp, the shadow cast by the daylight is colored yellow by the Mazda while the shadow cast by the Mazda is a good blue by contrast.

We have called the artificial light deficient in blue rays rather than superabundant in yellow rays (which would have the same effect on the second and third of our matches) because the first match showed no important difference in the yellows as between the two lights.